



Rajiv Gandhi Proudyogiki Vishwavidyalaya, Bhopal (M.P.)

Syllabus for Entrance Examination for Admission in Ph.D. Program

APPLIED PHYSICS

Mathematical Physics

Legendre, Bessel, Hermite, Laguerre and equations ; Physical applications, Generating function; Recurrence relation and orthogonal properties. Laplace and Fourier transforms and their applications. Solution of simultaneous linear equations, Gaussian elimination, pivoting, iterative method, matrix inversion. Numerical solution of ordinary differential equations, Euler's and Runge Kutta methods, predictor and corrector method. Elementary ideas of solutions of partial differential equations. BCC theory of Super-conductivity.

Electromagnetic Theory

Laplace and Poisson equations -- conductors and dielectrics -- boundary value problems -
- Ampere's and Biot-Savart's laws -- Faraday's law -- Maxwell's equations -- scalar and vector potentials -- Coulomb and Lorentz gauges -- boundary conditions at interfaces -- electromagnetic waves -- interference, diffraction and polarization -- radiation from moving charges. Theory of Plasma state and application.

Quantum Mechanics

Application of Schrodinger wave equation for particle in a box, linear harmonic oscillator and tunneling. Time independent perturbation method for non-degenerate and degenerate level and their applications , Normal Zeeman effect, first order Stark effect in Hydrogen atom, WKB method .

Solid state and semiconductor physics

Bloch theorem, Kronig-Penny model, origin of energy gap , Brillion zones, Number of possible wave functions per band, velocity of electrons according to periodic potential , Influence of electric field, effective mass, concept of hole.

Intrinsic and Extrinsic carrier concentration, Position of Fermi energy level , Carrier Drift, Variation of mobility with field strength-hot electron effect, Diffusion, carrier generation and recombination; Excess – carrier Lifetime, Continuity equation, Carrier density profile-diffusion length

Principle and working, characteristics and basic uses of following devices: FET, MOSFET, UJT, SCR, tunnel diode, Zener Diode, Solar cell, photo detector, LED and Quantum well structures. Magnetism and magnetic materials.

Nuclear and Particle Physics

Rutherford scattering -- basic properties of nuclei -- radioactive decay -- nuclear forces -- two nucleon problem -- nuclear reactions -- conservation laws -- fission and fusion -- nuclear models -- particle accelerators, detectors -- elementary particles -- photons, baryons, mesons and leptons -- Quark model.

Lasers and Fiber Optics

Laser rate equations: three- and four-level systems. Variation of laser power around threshold. Longitudinal and Transverse modes of laser cavity. Mode selection. Mode lasers. Single mode, multi mode, step index and graded index optical fibers, wave propagation through them. Pulse dispersion in optical fibers. Various losses in optical fibers. Fiber manufacturing processes: MCVD, PCVD, OVD and VAD and splicing of fibers, locking and Q switching. Ruby laser, Nd-YAG laser, Carbon di oxide laser, He-Ne laser, semiconductor Digital communication.

Electrodynamics

Maxwell's equations, boundary conditions for electric and magnetic fields, propagation of electromagnetic waves in air and ionized medium. Motion of charged particle in electromagnetic field: Uniform E and B fields, Nonuniform Fields, Diffusion across magnetic fields, time varying E and B fields.

Statistics & Research Aptitude

Mean, median, mode, basic concepts of probability, coefficient of variance, standard error, standard deviation, and correlation and regression analysis. Student t-test, F-test, analysis of variance (ANOVA), data graphics and data interpretation. Principles and various models of statistical optimization techniques, optimization softwares.

National and international scenario of scientific research, literature reviewing, reference citation, scientific and research journals, impact valuation, research article and patent drafting, various scientific websites, abstracts.

CHEMISTRY

Physical Chemistry:

Structure of atom, Quantum Theory, Hydrogen atom, valence Bond and Molecular orbital theories, variation and perturbation-symmetry. Laws of Thermodynamics, enthalpy, entropy, free energy. Ideal & non ideal solutions. Phase component systems. Colligative properties. Electrochemical cells, electrolytic cells. Kinetic theory of gases. Rates of chemical reactions, collision and transition state theory, photochemical reactions, catalysis. Solid state, Crystal system and lattices, miller planes, crystal defects, ionic crystals, metals. Nuclear chemistry. Colloidal state. VSEPR theory, uncertainty principle, Schrodinger's equation. Chemical Equilibrium : Free energy and entropy of mixing partial molar quantities, Gibbs-Duhem equation, equilibrium constant, temperature dependence of equilibrium constant.

Inorganic Chemistry:

Reactions of simple and industrially important compounds, boranes, carboranes, silicones, diamond and graphite. Hydrides and oxoacids of N,P,S and halogens. Boron nitride, borazines, phosphazenes. Xenon compounds. Hard soft acid base concept. Spinels. Characteristics of d and f block elements. Coordination chemistry. Theories of metal ligand bonding. Metal carbonyls. Chemistry of Lanthanides and Actinides : Spectral and magnetic properties; use of Lanthanide compounds as shift reagents.

Organic Chemistry:

Reactions, Synthesis and mechanism involving- Alkanes, Alkenes, Alkynes, Arenes, Alcohols, Phenols, Aldehydes, Carboxylic acids & their derivatives, Halides, Ketones, Nitro compounds, Amines. Stereochemical and conformational effects on reactivity and specificity. Heterocycles. Carbohydrates, Proteins, Nucleic acids. Bio molecules. Aromaticity: Huckel rule and concept of aromaticity ($4n + 2$) annulenes and hetero annulenes, fullerenes (C_{60}). Chemistry of natural products : Familiarity with methods of structure elucidation and biosynthesis of alkaloids, terpenoids, steroids, carbohydrates and proteins.

Analytical Chemistry:

Volumetric analysis, gravimetric analysis, TGA, Optical analytical methods, electro analytical methods, spectroscopic methods-UV, Vis, IR, NMR, ESR, Mass, X-ray diffraction techniques. Separation techniques. Chromatographic techniques. Electro analytical Techniques : Voltametry, polarography, amperometry, coulometry and conductometry.

Industrial Chemistry:

Industrial aspects of plastics, rubbers, ceramics, glass, inorganic acids HCl, H₂SO₄, H₃PO₄ etc.), corrosion, water, cement, fertilizers, alkalis and allied chemicals, pharmaceuticals, sugar, petrochemicals, pollution.

Statistics & Research Aptitude

Mean, median, mode, basic concepts of probability, coefficient of variance, standard error, standard deviation, and correlation and regression analysis. Student t-test, F-test, analysis of variance (ANOVA), data graphics and data interpretation. Principles and various models of statistical optimization techniques, optimization softwares.

National and international scenario of scientific research, literature reviewing, reference citation, scientific and research journals, impact valuation, research article and patent drafting, various scientific websites, abstracts.

APPLIED MATHEMATICS

Integral Transform:

Laplace Transform and Inverse Laplace Transform, Fourier Transform, Fourier Sine and Cosine Transform, Complex Fourier transform, Inversion formulae, linearity property, Change of scale property and shifting property, Fourier transform of derivatives, Parseval's identity. Application of Laplace and Fourier Transform, Definitions of Hankel transform, Mellin Transform, and their elementary properties.

Fourier Series & Vector Calculus:

Fourier Series: Euler's Formulae, Dirichlet's Conditions, Fourier Series for Continuous and Discontinuous Functions, Half-Range Fourier Series.

Vector Calculus: Gradient, Divergence & Curl, Vector Differentiation, Vector Integration (Line, Surface & Volume), Gauss-Divergence, Stoke's & Green Theorem.

Differential Equations:

Ordinary Differential Equations: Differential Equation of First Order and First Degree, first order and Higher degree, Linear Higher order Differential Equation with Constant Coefficient, Homogeneous Linear Differential Equations, Simultaneous Differential Equations.

Partial Differential Equation: Linear Partial Differential Equation of First Order, Non-Linear Partial Differential Equation of First Order, Homogeneous Linear PDE with Constant Coefficients, Application of Partial Differential Equations.

Numerical Analysis:

Error and Approximations, Solution of Algebraic and Transcendental Equations, Interpolation for equal and unequal intervals, Inverse interpolation. Numerical Integration and Numerical Differentiation, Numerical Solution of Simultaneous linear equations, Solution of ordinary differential equation using Numerical Methods.

Operations Research:

Introduction to Linear Programming, Solution by Graphical and Simplex Method, Concept of Degeneracy and Duality, Optimal Solution of Transportation Problems, Assignment Problems, Job Sequencing Problems.

Functions of Complex Variable:

Complex Function, Continuity, Differentiability, Analytic Function, Complex Integration, Cauchy's Integral Theorem, Cauchy's Integral Formula, Zero's & Poles, Complex Sequence, Series and Power, Taylor's and Laurent Series. Residue (Definition), Residue Theorem, Evaluation of Real Integral, Conformal Mapping.

Probability & Statistics:

Probability, Distributions (Binomial, Poisson, Normal), Random variables, Distribution function, Probability density function, Expectation, Moments, Moment generating

function, Test of Hypotheses, Level of significance, Small and Large sampling, Chi-Square test.

Coefficient of variance, standard error, standard deviation, and correlation and regression analysis. Student t-test, F-test, analysis of variance (ANOVA), data graphics and data interpretation. Principles and various models of statistical optimization techniques, optimization softwares.

Functional Analysis:

Normed spaces: Basic definitions & properties, Examples of normed spaces, Banach space, Factor space as Banach space, Convergence and absolute convergence, Necessary and sufficient condition for completeness of a normed linear space, Linear operator, properties of linear operators, Dual space.

Linear Algebra:

Group, Sub group, co-sets, normal Sub group, Semi group, Ring and Fields, Vector spaces, Vector subspaces, Linear dependence and independence, Bases & Dimension, Linear transformations, The Algebra of linear transformation, Rank of a Linear transformation, Characteristic roots, Relation between characteristic roots and characteristic vectors. Metric Space.

Graph Theory:

Definitions, Sub Graph, Finite and Infinite Graphs, Incidence and Degree, Isolated Vertex, Pendant Vertex, Null Graph, Isomorphism, Sub graphs, Walks, Path and Circuits, Connected & Disconnected Graph, Components, Euler Graph, Operation of Graphs, Hamiltonian Path and Circuit. Tree, Decision, Rooted, Binary, Spanning Trees, Properties of trees.

Research Aptitude

National and international scenario of scientific research, literature reviewing, reference citation, scientific and research journals, impact valuation, research article and patent drafting, various scientific websites, abstracting services.